LOW WATER CONSUMPTION

A New Goal for Coal

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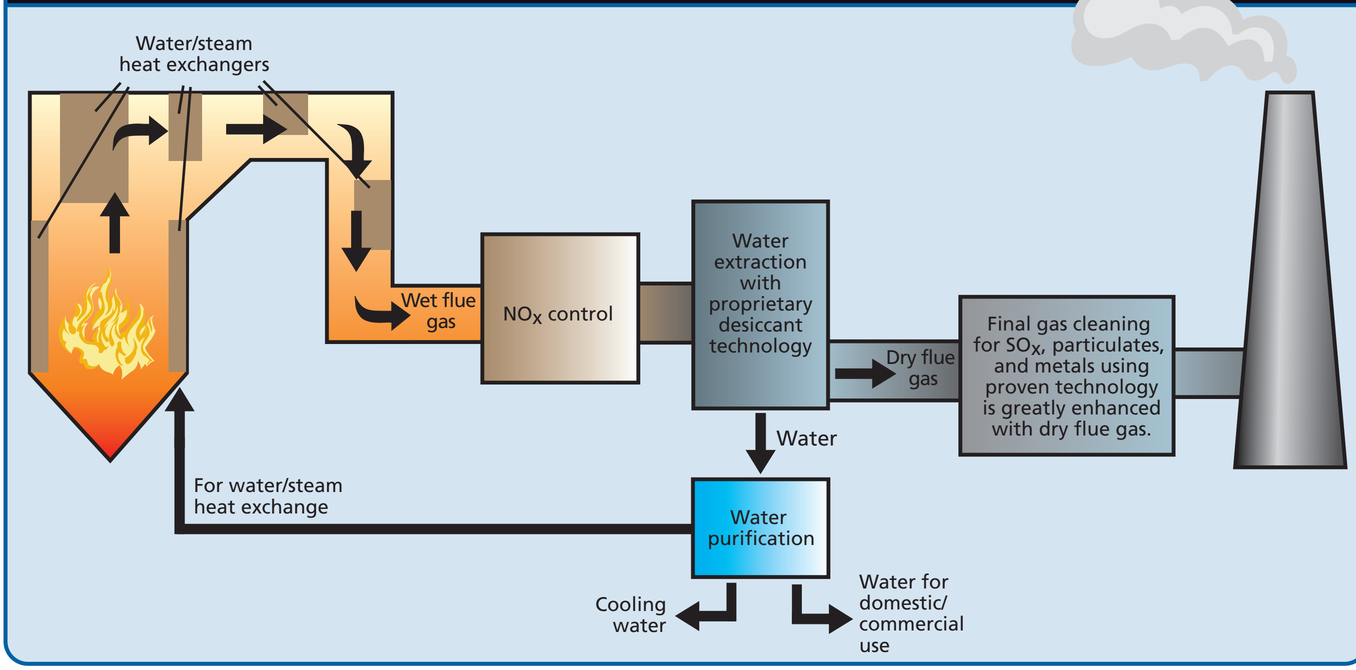
There are, according to estimates by the U.S. Geological Survey and other organizations, some 980 billion metric tons of coal buried worldwide. Taken at face value, that coal could supply the energy needs of the world for many years. But while coal is plentiful, burning it to generate power places a tremendous burden on the global water supply. At present, although coal plants are subject to a variety of regulations to reduce emissions of pollutants including mercury, sulfur dioxide, carbon dioxide, and particulate matter, there is no technology in place to recover water, one of the world's most valuable resources.

Now, with the impetus of a $930,000 contract from the Department of Energy National Energy Technology Laboratory (NETL) and a $470,000 buy-in from industry giant Siemens Westinghouse, the University of North Dakota Energy & Environmental Research Center (EERC) has begun a two-year pilot program to study the use of commercial desiccant technology as a way to remove, treat, and use water from coal power plant flue gas—water that originates within the coal itself. Using desiccant technology may prove to be one way that coal-fired power plants can reduce their draw on local fresh water supplies.

Coal, the fruit of the earth, can actually have a significant percentage of water in its makeup, says EERC director Gerald H. Groenewold. North Dakota lignite, the type that the EERC researchers are currently working with, can be 30% water, he says, and he and his colleagues

Using Desiccant Technology to Capture and Use Water from Coal



EERC

have even worked with some coal from Australia that is 67% water. "At that point, it's hard to recognize it as a solid resource," says Groenewold, "but it is." Ideally, some of that water, which generally goes out the stack, would be captured and reused in the plant or returned to the local water supply.

Desiccant technology is currently used to dry the air in facilities such as ice rinks, where there is a large volume of water but the surrounding air must be kept relatively dry. Besides reducing water use, the technology has other potential advantages for power plants, says EERC associate research director Thomas A. Erickson. "For one, if you dry the stack gas, it actually becomes easier to capture the suite of contaminants involved in coal firing. . . . And although research is ongoing, it appears possible that capture of excess water might have a positive impact on the formation of certain pollutants, such as sulfur dioxide, downwind from the plant."

Water for Power

According to Groenewold, power generation overall is second only to agriculture as the largest domestic user of water. Thermoelectric generating facilities make electricity by converting water into high-pressure steam to drive turbines. Once through this cycle, the steam is cooled and condensed back into water (some current technologies also use water for this step, which increases the plant's need for water still further). In coal plants, water is also used to clean and process the fuel itself.

The U.S. Geological Survey estimates that as of 2000, thermoelectric plants (including both nuclear and fossil fuel) withdrew 195 billion gallons of water per day, of which 136 billion gallons was fresh water. About 97% of the water that these plants withdraw is returned to the source water, says Thomas Feeley, technology manager for environmental and water resources programs for the NETL, and about 3% goes up the stack as evaporative loss.

"Loss through evaporation becomes an issue [for power plants] because water is so very limited in many parts of the country, such as the western United States," says Feeley. In many of these same areas, a great deal of agriculture and some of the most rapid population growth is taking place, placing further demands on water resources.

Feeley adds, "Heavy water usage can have a long-term impact on aquifers in the region, because once depleted, they can take hundreds of years to recharge." He says power plant water usage can also potentially harm fish eggs and larvae and a variety of other aquatic biota in their early stages. Aquatic life requires particular combinations of fresh water flow, temperature, and other factors, all of which can be impacted by human activity. Also, when water is released back into streams and rivers, it must be not only cleaned, but also cooled to tolerable temperatures so as not to kill fish populations or encourage excessive algal growth—and that requires still more water.

The electrical power industry has felt the brunt of the water crisis on numerous occasions over the past few decades, says Feeley, citing several power plants that were denied permits in the West and Southwest. "I have heard utilities say that water permits are more difficult to get than air permits, simply because of the rapidly increasing pressure on the water supply," he says.

There are currently no federal requirements for power plants to consider alternative water sources, but several states nevertheless are looking at different options. New Mexico is looking at tax incentives to encourage power plants to use so-called produced waters (the brackish waters brought to the surface during oil and natural gas production), and some states on the East Coast are looking at the possibility of using waters pumped from coal mines—waters that, because of their acidity, will need significant treatment, at an additional cost to plant operators. The goal, then, is to find other ways to supplement primary water sources in an economical fashion. That's where the EERC project comes in.

A New Wave of Thought

Barbara Carney, who is NETL manager for the EERC project, says commercial desiccation units operate in a manner similar to flue gas desulfurization units. "The [gas] you're cleaning or drying is sprayed into a large vessel containing beds of the desiccant, and then you remove the

Promise on the horizon? Capturing and reusing water that is locked inside coal may become critical in areas where water shortages are chronic and severe.

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desiccant, take it to another chamber, heat it to drive off the water, and then capture, condense, and treat the water." Typically, she says, this heating is done with natural gas, but the EERC researchers will try to use waste heat from the power plant itself.

Carney says there are several issues this pilot project will have to address. For one thing, desiccants such as lithium bromide (the most common commercial desiccant) are fairly expensive, so the project will also look at how long desiccants can be recycled before they have to be replaced. Lithium bromide also carries some environmental baggage of its own, as it can cause kidney damage, disturbance in thyroid function, and damage to the eyes, skin, and respiratory tract. So the project will also consider alternative desiccants that have yet to be selected.

But the biggest concern, in Carney's opinion, is the presence in flue gas of nitrogen and sulfur oxides, which are highly reactive. "We don't have any idea what their impact will be on the desiccant substance," Carney says. "They make everything more complicated."

Kent Zammit, manager of cooling water technologies in the Environment Division of the Electric Power Research Institute, a nonprofit research consortium, is familiar with the EERC work. He notes that cost will be the deciding factor for whether any particular system will be adopted industrywide. And, he says, the question of cost is both a near-term and a long-term issue. "As it's a relatively new project, I haven't seen any reports out of the EERC work, but I know the concept is at least technically feasible. What it comes down to is the cost per acre-foot of water generated," says Zammit.

By way of example, Zammit cites the San Juan Generating Station in northwestern New Mexico, which supplies a large part of the state's power needs. Zammit says that under prior agreements set up several years ago, San Juan pays state and local water resource agencies about $10 per acre-foot of water. If they had to buy new rights today, he says, they might expect water to cost $600–700 per acre-foot. If San Juan goes ahead with a plan to bring in produced water to treat and use within the plant, it could cost about $2,000 per acre-foot—"very expensive," says Zammit, "but a reliable source of badly needed water in times of shortage. And I think that shows where the EERC project could be very valuable."

It seems improbable that enough water could be recovered from flue gas to supply all of a power plant's needs, so there will still be some water costs involved. But if the idea pans out, capturing and using water from the fuel itself could decrease the need for outside sources enough to drive down the cost. How much water can be recovered from coal—and how economically it can be done—will be another part of this study.

Harnessing Resources Wisely

Coal, Groenewold says, has a bad name on a number of fronts, but it's also a tremendous indigenous resource that, if properly used, could enhance the energy security of the United States. "Coal is a difficult substance to use safely," he says. "But we have billions of metric tons of it, so I think it's a resource we can't reasonably ignore. The key will be to use the new technologies that are becoming available to us to burn coal in a safe enough manner so we can meet our energy needs without degrading our environment."

Will implementation of such technologies require some sort of national incentive program for industry? Groenewold doesn't think so. "I think implementation of processes such as [desiccant technology] will occur not because of federal tax incentives, but because people are finally coming to realize that water is [a] limited and irreplaceable global resource," he says. "Making better use of what water we have is going to be the biggest challenge of the twenty-first century, and I think it's that realization, more than anything else, that will make projects like this a reality."

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Suggested Reading

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